10

Megaliths: Mathematics and Astronomy

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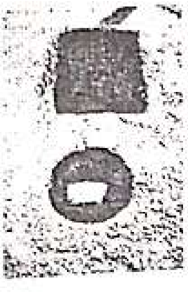
Introduction

Megalithic monuments are structures of large, roughly dressed stones erected as sepulchral monuments or as memorials of notable events. South Indian Megaliths with Iron technology have exhibited excellent culture. Some Tamil scholars and archaeologists associate them with that of Sangam Age[1] (the ancient / classical Tamil period as depicted by the Pattuppattu and Ettuttogai literature).

Classification of Megaliths

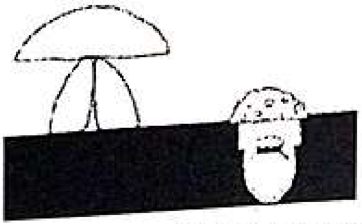
The archaeologists have classified the Megaliths into different groups. Allchin[2] has classified into six main types. Dikshit[3] has done on the parallels of European typology main – six categories and sub-division of three main categories. The Megalithic burials have been found in different forms:

- ***Rock-cut cave:*** A cave cut inside a mount / hill (burial examples are at Chovvur, Kakkad, Porkalam in Kerala).



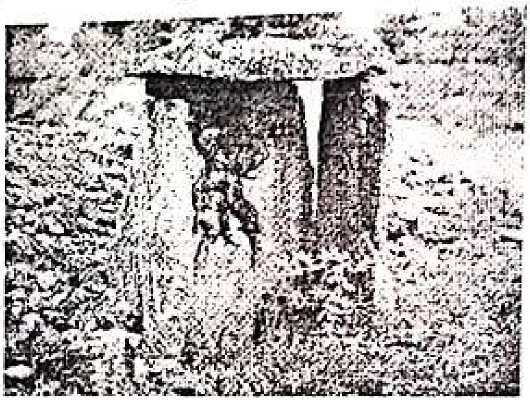
Later, the rock-cut caves were used for Rishis, Jain ascetics and Buddhist monks as shelters, monasteries and tombs, perhaps finally temples were evolved out used for worship.

- Umbrella Stone: Stones arranged in the form of Umbrella.
- Hood stone / Topikkal / Kuda-kallu / Mushroom / hat-stone: Stones arranged as if a cap is placed on head.



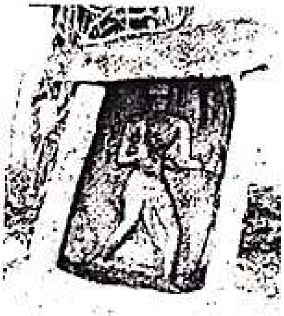
Many examples are in Kerala. The figure on LHS shows typical category and pit-burial, where urn is covered with a stone.

- Menhir, Alignments and Aknues : Stones erected straight or monolithic pillars planted vertically into the ground with height varying from 14 to 16 feet.



Examples are at Janampet, Warangal, Oiklihal, Maski, etc. In Sangam literature, they are mentioned as Nadukal and generally called Pandukal.

- Hero-stone: Erected in remembrance of the dead.

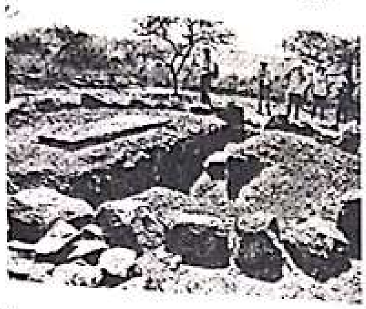


There have been many examples of hero-stones throughout ancient Tamizhagam / South India. The above is an example of menhir-cum-hero stone. Photos from R. Nagasamy's web-article[4] (for reference, see below).

Dolmenoid Cist: Simply, it is a tomb made of stone. It consists of square or rectangular box-like graves built several orthostats, one or more for each side supporting the superincumbent capstone consisting of one or more stones.

Examples are at Sanur, Kunrattur, Chingleput (Tamilnadu), Brahmagiri, Chitrdrug ; Jiwarji, Gulbarga (Karnataka), *Cairn circle:* Stones arranged in the form of a circle. They consist of a heap of stone rubble enclosed within a circle of boulders. This category include Pit-burials, cairn circles, urn-burials also.

The example of Nagarjunakonda is shown on LHS. Now, it was disturbed due to Dam construction and displacement of archaeological structures.

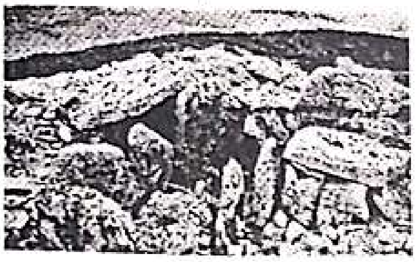


- *Pit burials:* Deep wells or pits, cut in rows into subterraneous rocky grounds in depth from 10 to 12 ft. and 4 to 9 ft. in diameter.

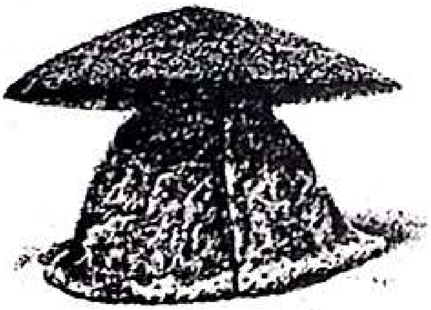
Examples are at Sirumurugai, Coimbatore, Amritamangalam, Chingleput (Tamilnadu); Chikkinahalli (Karnataka).

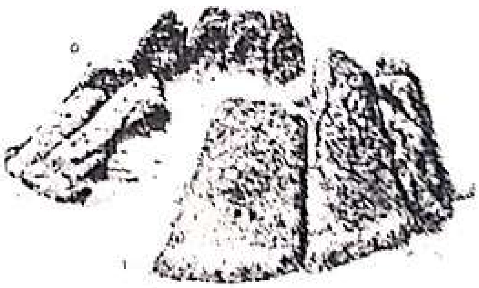
Barrows: The barrows or earthen mounds are the underground burials, circular, oblong or oval in plan.

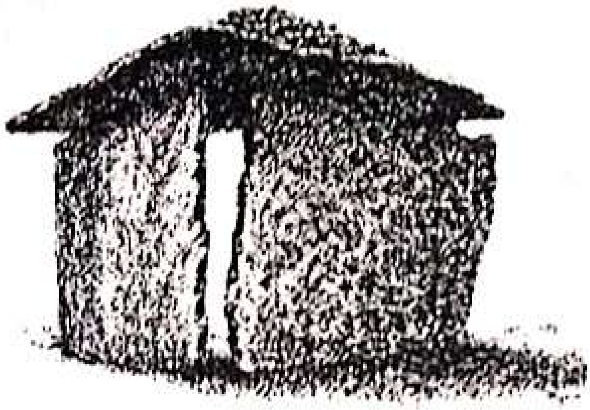
Examples are at Hasan, Mysore (Karnataka).



Actually, the South Indian Megaliths have many times, combination of more than one pattern or category as mentioned. For illustrative purpose, more topical, dolmens, dolmen arranged in the form of circle are depicted below. All are of Topikal / Kudai kallu categories, except the second figure, which comes under "Multiple Hood stones":







Most of the studies and the interpretations thereof delve on the western or outside origin of Megaliths and the "Aryan-Dravidian" race theories and hypotheses. However, such stone / burial arrangements have not been studied in conjunction with mathematics or astronomy as done in the case of Stonehenge. It has to be noted that the western scholars who have made so much about the Stonehenges, have surprisingly silent about the Indian counterparts. Even Fergusson and others who have done such meticulous work on Indian stone architecture have not made any reference about this aspect. Recently a few Indian scholars[5] have attempted to interpret Indian megaliths in astronomical angle (after 70 years of interpretation of the British stonehenges) as noted from the websites, however, they have not explained the details.

Stonehenge

"Stonehenge" originally meaning "hanging stones" (stan+hangan), but it is a group of stones erected, embedded to the earth and arranged in a circular pattern. It is a prehistoric ritual and the most celebrated of the megalithic monuments, situated on Salisbury Plain, north of Salisbury, England, and dating from the late Stone and early Bronze ages[6] (c. 3000-1000 BCE). It is surrounded by a circular ditch, 104 m (340 ft) in diameter and 1.5 m (5 ft) deep, within which is a bank and a ring of 56 pits known as Aubrey holes (after their discoverer, the British antiquarian John Aubrey). At the northeast end a break in the ditch affords access to a ditch-bordered avenue that extends in a generally northeastward direction to the Avon River. The avenue is 23 m (75 ft) wide and nearly 3 km (2 mi) long.

The monument itself consists of four concentric ranges of stones. Stonehenge was desecrated sometime between 55 BCE and 410 CE by the Romans, who tore down a number of the upright stones. The function of Stonehenge has long been a matter of conjecture[7]. In 1964 the American astronomer Gerald S. Hawkins reported findings obtained by supplying a computer with measurements taken at Stonehenge together with astronomical information based on celestial positions in 1500 BCE when Stonehenge was in use. According to Hawkins the complex could have been used to predict the summer and winter solstices, the vernal and autumnal equinoxes, and eclipses of both the sun and moon. Moreover, a variety of other information pertaining to the sun and moon could also be predicted with remarkable accuracy. Hawkins concluded that Stonehenge functioned as a means of predicting the positions of the sun and moon relative to the earth, and thereby the seasons, and perhaps also as a simple daily calendar.

South Indian Megaliths Analysed[8]

In Tamizhagam / South India, characteristic Megaliths have been found and still available for study. Here, they are analyzed under, to find out the significance of their arrangement, pattern or symmetry noted. Such assembly or layout was accidental or intentional is also critically discussed. First the place and Megalithic arrangement are given. Then, it is interpreted.

Place and Megalith arrangement: Nagarjunakonda (*Indian Archaeology – A Review*, 1957-58, Plate 1B, p.5).

Details: Circular form megalithic burial with four pits.

Interpretation: The stones are arranged in the form of a circle. The four pits are exactly the four sectors of a circle. The division is exactly at 90°. The north-eastern sector contains a crushed pot entombed within the high cairn.

Place and Megalith arrangement: Junapani, Nagpur Three megalithic circular burials (IA, 1961-62, Plate LIV A and B, p.33).

Details: Megalith II consists of a double circle of untrimmed boulders with average diameter of 10.21 m.

Interpretation: Knowledge of Concentric circles.

Place and Megalith arrangement: Hathinia hills, right bank of Chandrprapha, Tehsil Chakia, Varanasi Dist.

Details: Stone circles with cairn (Pl. LXXXIII A) and stone circle with upright stones erected in the middle (Pl. LXXXIII B), the former being the dominant type. The stone circles range from 7.62 to 9.14 m. in diameter with cairn raising to a height of 18.0 to 2.1 m. some of the circles measured as 18.28 in diameter. The exact nature of these megaliths and their relationship with those of South India remains to be determined by excavation.

Interpretation: Stonehenge type erected stone is found in the plate LXXXIII B and hence its astronomical position is significant.

Place and Megalith arrangement: Hithinia-Pahar, Varanasi district (*IA*, 1963-64, Plate. XXXVIII A and B, p.57).

Details: The excavation revealed a cist within a grave pit, lying almost in the centre of the stone-circle (Pl. XXXVIII B). The cist was oriented east-to-west and measured 1.82 x 0.96m. The sides of the cist-chamber were made of small stone pieces resting directly against the side-walls of the grave-pit. Among the finds obtained were four stone slabs of indeterminate use, a fragmentary rim of black-and-red ware and a few other fragments of pottery. No skeletal material was recovered.

Interpretation: The east-west orientation has been ingrained in the minds of Indians of all times.

Place and Megalith arrangement: Kuuntitoli, Ranchi (*IA*, 1965-66, Plate III A and B, p.10).

Details: A post-crematory burial consisting of a circular pit filled with 37 pots with 59 lids made of same material, shape and fibre. It appears as if the bigger circular pit was filled with smaller circular pots completely.

Interpretation: How a bigger circle can be divided into as many as small circles.

Place and Megalith arrangement: Halingali, Bijappur District (*IA*, 1965-66, Plate. XVI A and B, p.34).

Details: Megaliths I and II represented stone circles measuring respectively 5.6 and 6 m. in diameter. No cists were found in any of these burials. Besides a few potsherds of the megalithic fabric, these burials did not yield anything. Megalith III consisted of a cist of the Greek cross type (Pl. XVI A), having pillars along the principal axis and was perhaps one of the largest megaliths in the area. Its enclosing rectangle and the cist measure respectively 11 m. square and 6.5 x 4.75 m. the orthostats of the cist and the rectangle surrounding the cairn were found to be structural walls. A large number of pottery of the usual megalithic fabric, iron objects etc., and a few fragments of human bones were collected from the burial.

Interpretation: The so called Greek cross is nothing but, "the members are of equal length and interest at the centre". In other words, the circular shape is divided into four equal parts (sectors) with the lines at 90°. The pillar erected along the principal axis is significant, as the erecters evidently knew the cardinal directions and points and their orientation.

Place and Megalith arrangement: Kunrattur, Chingleput; Sanur, Chingleput (Tamilnadu); Brahmagiri, Chitradrug Jiwarji, Shorapur Taluk, Gulbarga Dist. (Karnataka).

Details: one outer circle of bigger stones and another smaller one; the smaller circle consists of four-chambered burial pit made of stone walls; in between the bigger and smaller stone circles, 5 to 6 number circles are there with rubbles, but now appearing as disturbed or without any circular pattern.

Interpretation: Concentric circles and the inner circle is divided into four equal sectors and the stone slabs are placed at 90°.

Place and Megalith arrangement: Hunur, belgaum (Karnataka) (IA, 1968-69, Plate XXIV A and B; XXV A and B, pp. 20-21).

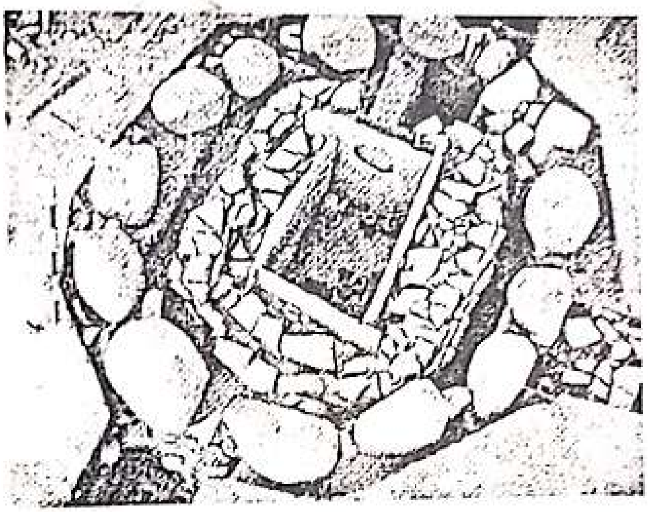
Details: Though, there were been many Cist monuments, most of them ransacked by the treasure hunters. However, some were intact. The megalith consisted of a huge cairn entombing three cists enclosed by stone-circles and platforms (Pl. XXIV B). Two of the cist-tombs were approached by passage running south-north direction.

Cist 1 was square on plan (2.5 m) and was surrounded by a circle of dressed stones, laid in six courses and further enclosed by a rectangular platform (15 x 15.6 m) of rubble lined with stone slabs. It was approached by a passage (Pl. XXV A), the walls of which were made of upright stone-slabs and the floor of rammed rubble. Measuring 40 to 50 cm. in width, the passage was blocked at the southern-end by an upright slab. Cist 2 was rectangular on plan (3.25 x 1.3 m.) and was enclosed by a stone-circle built over the rubble bed in a single course and further enclosed by a platform (11.4 x 9.75 m.). It was also approached by a passage (Pl. XXV B), of which the walls were built of dressed stones of smaller size, laid in four courses. On the southern end of the passage was another cist labeled 3 measuring 3.55 x 2.95 m. Two dressed stone slabs were found placed in a raised portion on the western side. In addition, a small circle was also found on the western side of the passage.

Interpretation: The meticulous design proves the well-conceived plan of the megalithic builders. The geometrical pattern and north-south direction followed prove that such arrangement was intentional and not accidental.

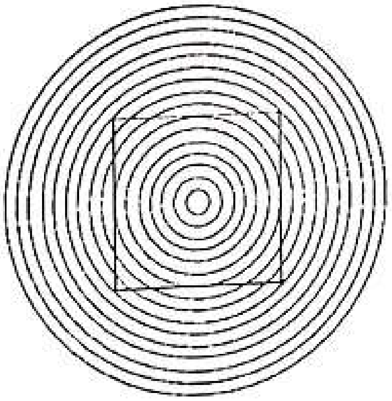
Place and Megalith arrangement: Brahmagiri cist and stone circle (from Wheeler 1948).

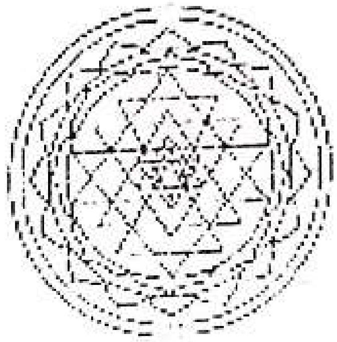
Details: Inner chamber is made of four stone slabs erected vertical. One stone slab facing south has a circular hole. In fact, another chamber is visible beneath the stone-box structure. It is surrounded by two rows of stones in oval shape. It is again surrounded by big stones in circular form. The entire formation is below rocky structure. The four direction orientation is clearly marked by channels cut.



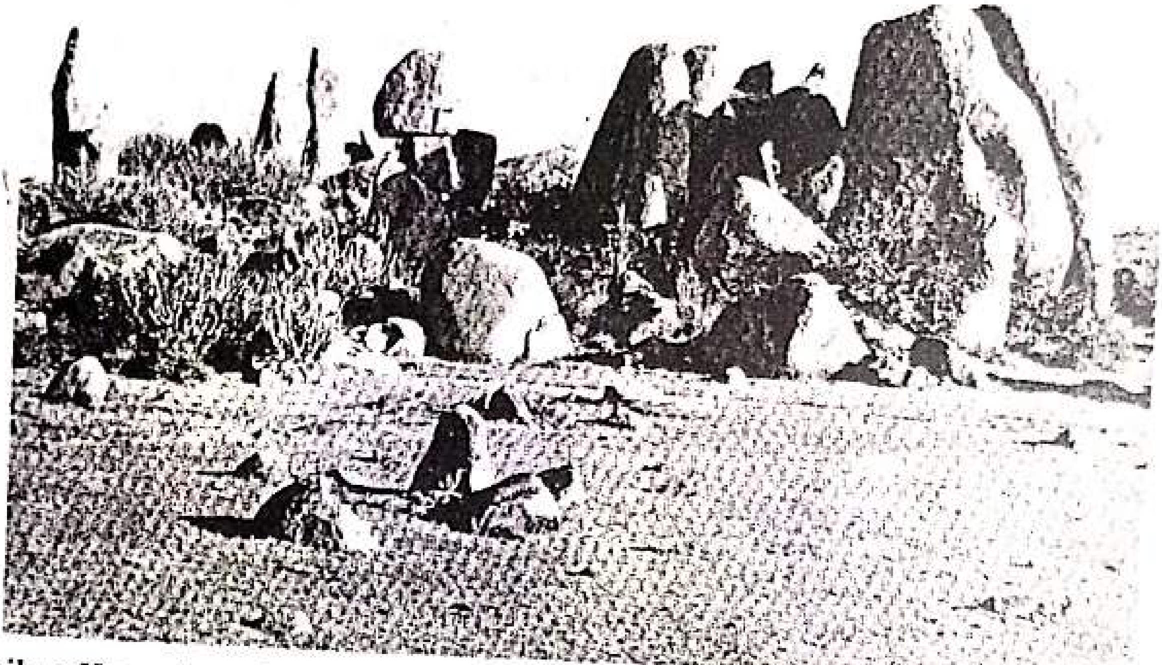
Interpretation: The concentric row encircling a square is significant, as it resembles rough model of simple Sri-Chakra.

A sample figure of Sri Chakara is shown on RHS. A square drawn on many concentric circles appear as sides bent inside. Circling a square and squaring a circle had been an age-old problem, in which Indians could have succeeded.





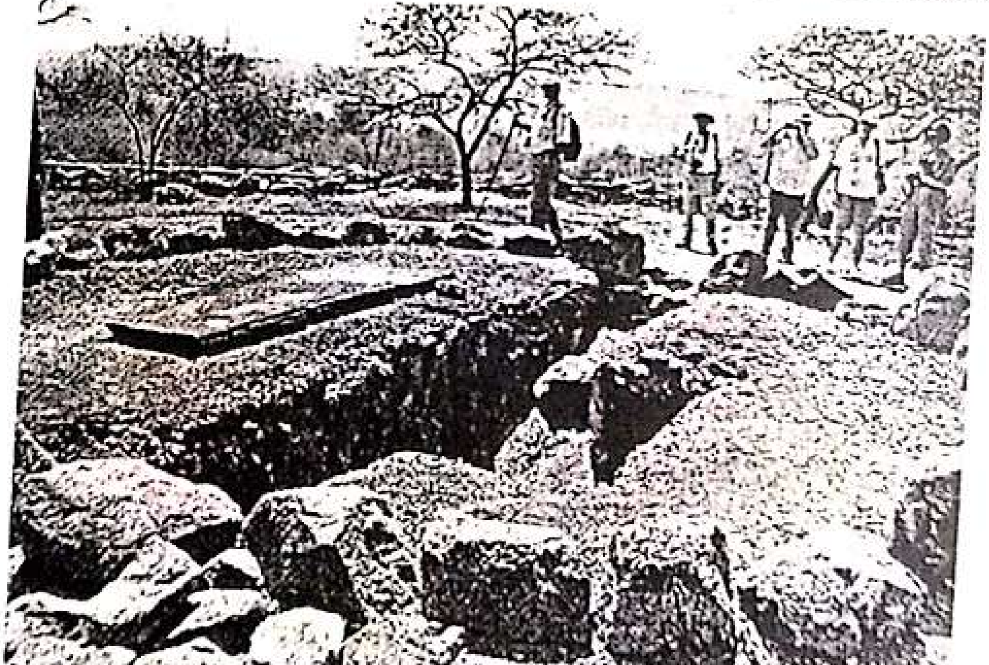
Place and Meglith arrangement: Stonehenge type dolmen, Anantpur, A.P.



Details : Huge stones have been arrnaged in stonehenge style in circular shape.

Interpretation: The areal figure is not available, otherwise the pattern can be well studied.

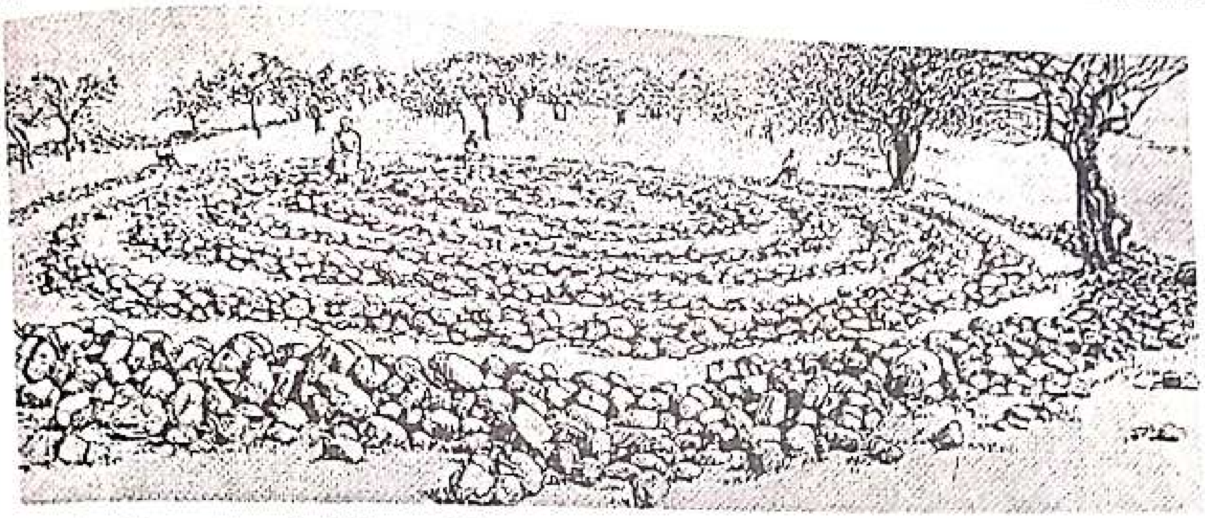
Place and Megalith arrangement: Nagajunakonda, Cist burial, 1st Millennium BCE.



Details: An early cist burial provides evidence that this region was occupied in prehistoric times. The burial pit was enclosed in a stone circle and covered by a heap of stones. Four human skulls were originally buried in the pit.

Interpretation

Place and Megalith arrangement: Sitimani, Gulbarga, Karnataka, Picture and details are from: http://www.labyrinthos.net/indialabs.htm

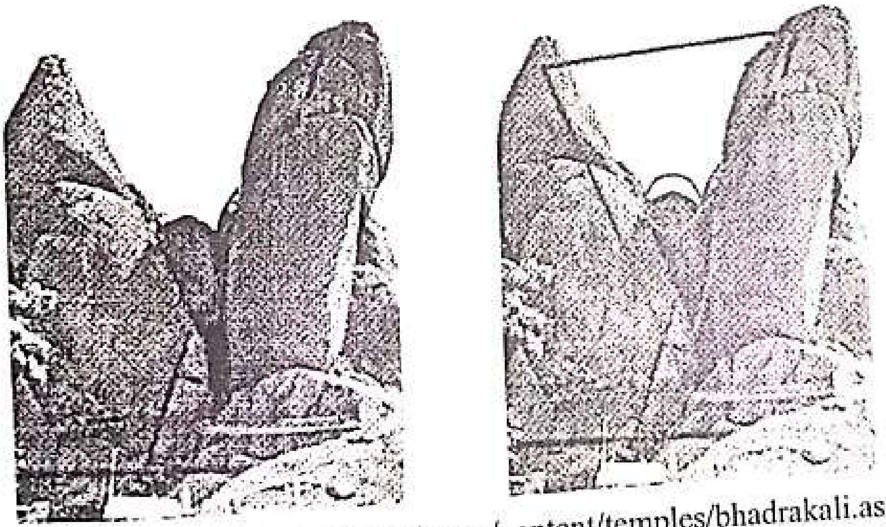


Details: The author Jeff Saward interprets the arrangement as "Labyrinth", as he studies about it. But, it is evident that the stones are arranged in eight concentric circles, but at the time of observation as depicted in "the diagram, the stones might have been disturbed to appear so. It is unfortunate that the structure was submerged as noted by him due to a dam project. It was called as "Lakshmana mandala" by the local people.

Interpretation: It is a perfect stone arrangement pointing to concentric circles, division of a circle into sectors, sectors depending upon angles etc.

Plan and Megalith arrangement: Hanamkonda, Warangal, AP.

A temple of Goddess has been constructed specifically choosing a spot where two stones are arranged as inverted triangle. In this case the rock Yantra is the huge inverted triangle that bespeaks the presence of the Mother Goddess, the Yoni Yantra, or Womb Yantra. (compare with the interpretation of grail).



Photos and details from: www.indiavogi.com/content/temples/bhadrakali.asp

Inference: The construction of Megaliths shows that the people have applied much of their minds, labour and technology. They are not just handiwork of cave-men, hill-men or tribals bringing stones of different sizes, shapes and forms and placing on the dead or the spot where the people killed. The huge size and dimensions; shaping / forming of stones; digging and erection; geometrical arrangement and orientation prove the knowledge behind.

- From the above figures, it is evident that the Indian megalithic builders had some specific plan for their construction.
- The ground-plan has been as simple as circle (oblong, oval, ellipse etc.) or square (rhombus, rectangle etc.) or combination (concentric circles enclosing square etc.) thereof.
- In celestial view, the movement of Sun, Moon and other visible planets, certain asterism are noted and recorded.
- Their mathematical knowledge is evident, as without counting, the arrangement could not have been possible.
- They must have had certain implements to bring the stones, cut, chisel and arrange in such manner.
- Chaitya and temple construction resemble Megaliths in many aspects. However, the time gap between two cultures and periods is intriguing as it is just 1200 years.

They could not have all of sudden conceived the numbers, figures and application to material things to bring out technology. Here, the dating of South India Megaliths has been *c.*1000-300 BCE. As pointed out, it is equated with Sangam period. Thus, the number system and geometry must have prevalent earlier, so that the Megaliths implemente could have come into existence. As mostly, they are in circle and square shapes, the possibilities are studied:

<table>
<tr><td colspan="5">A circle is the basic perfect figure. It can be divided into equal parts.</td></tr>
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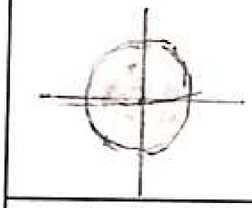
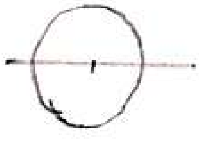
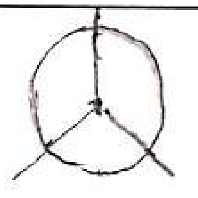
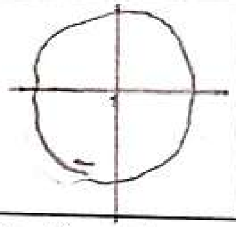
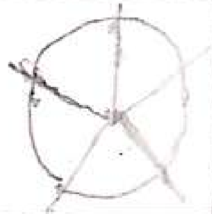
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr><td colspan="5">Such division implies division of sectors with 180u, 60u, 45u and so on. Similarly, a square can be divided into equal parts as shown below:</td></tr>
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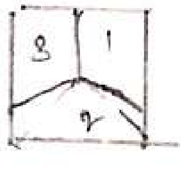
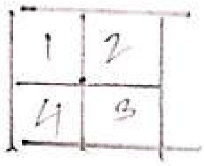
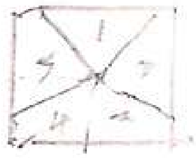
<td> </td>
<td> </td>
<td> </td>
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Here, a question may arise, why a square cannot be divided into three, five, six, seven, nine, and so on?

A circle can be divided into equal parts as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and so on up to n corresponding to angles of 360, 180, 90, 60, 45, 30 and so on......

But, a square cannot be divided into (3), (5, 6, 7), (9, 10, 11, 12, 13, 14, 15), (17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31),................. with exception of 6, 12, etc.

Thus, the numbers left out can be written as a series - 1, 3, 7, 15, 31, ...

The difference of this series being - 2, 4, 8, 16, ...

Thus, naturally they must have spent much time to find out the relation between circle and square.

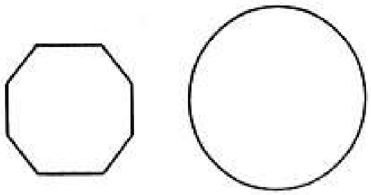
Before that, the possible origin of 0 and other numbers and their relation to geometrical figures has to be analyzed:

- A point or dot is the first thing to be initiated.
- From a point, if we have many points and they are joined together, we may get a curve or a line.
- Thus, we have two possibilities – a curved figure or a lined figure. Which is the uniformed curved figured by joining continuous, sequential and successive points?
- Even if such a figure has to be formed with the conditions, it should have a point of reference or origin.
- Therefore, if a point of reference or origin is taken, how the uniformed curved figured by joining continuous, sequential and successive points? As point is connected with it, expanded point is viewed and thus, the figure obtained is-

. → 0 → O → ◯ → ◯ and so on.

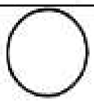
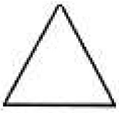
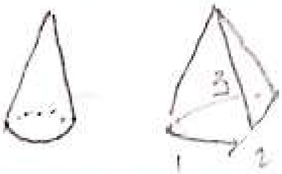
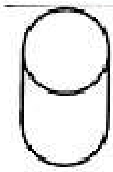
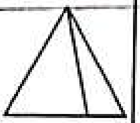
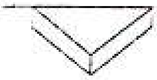
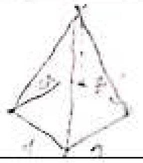
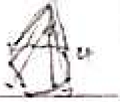
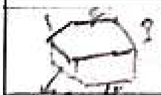
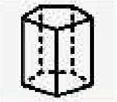
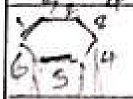
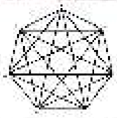
- How, an uniformed lined figure is obtained like this?
- What is an uniformed lined figure? No doubt that a man could have thought of it forming with minimum or more sides, as it has to be with sides.
- How a lined figure could be drawn with minimum sides?
- One side? No.
- Two sides – no.
- Three sides – yes. What is it? A triangle – △
- Next? A square – □.
- Then, a pentagon – ⬠
- Hexagon, ⬡ and so on.
- What is it? Is it not a sequence -1, 2, 3, 4, 5, 6,.............?
- Out of these figures, for uniformity, □ is selected.
- Thus, the problem of comparing and equating ◯ and □ started.
- Of course, we go on increase the sides of a polygon, we get a circle ! Yes, the circle is nothing but a polygon with infinite sides!

1. The point is the smallest circle that could be drawn with-zero radius.
2. The circle is the polygon with infinite sides.
3. The Polygon is nothing but a circle, a single sided figure, if its sides are increased to many sides with the limit / condition that the smallest polygon that could be drawn is a triangle.



Thus, one could imagine, visualize and form other figures easily. Here, the method explained is based on the number and logical system involved.

The Conversion of Two dimensions into Three Dimensions: We have seen how a dot / point evolves to a circle, successive points to a curve or line, curve to closed or open, line to triangle, square and so on. This naturally leads to imagine solid or three dimensional figures, as man deals with or handles such figures. How the solid or three dimensional figures are formed?

Figure	Describing the formation of sides	Number of sides
•	The Point	No sides.
	The Circle	One side on a plan.
	The sphere Total = 1 side	Solid figure with one side
	The Cone Base - circle - 1 side, conical side - 1. Total 1 + 1 = 2	
	The Cylinder Top and bottom - 2 sides Circular, Cylindrical side - 1 Total = 2 + 1 = 3	Solid with three sides.
	The Pyramid / Tetrahedron Base - triangle - 1 side, Triangular sides - 3. Total = 1 + 3 = 4	Solid with four sides. Solid with five sides.
	Alternative - base - square - 1 side. Triangular cone placed on it - 4 sides Total = 2 +. 3 = 5	
	Alternative - Bottom - Pentagon - 1 side. Triangular sides - 5 Total = 1 + 5 = 6	Solid with six sides. Solid with seven sides.
	Pentagon top & bottom 2 side 3 Rectangular - 5 sides Total = 2 + 5 = 7	
	Hexagonbase - top and bottom - 2 sides Sides - 6 Total = 2 + 6 = 8	Solid with eight sides.
	Heptagon base - top and bottom - 2 Sides - 7 Total = 2 + 7 = 9	Solid with nine sides.

See the unique properties of the Point:

- It has no dimensions.
- It is neither a two-dimensional nor a three dimensional figure.
- Even though it is conceived, perceived and even drawn on a plan, its space cannot be perceived.
- However, it is origin for all geometrical figures.
- Thus, it is similar to zero and that is why, ancient Indians represented zero with "." symbol besides '0'.
- Still, it plays a role in two dimensions and three dimensions.
- It is origin for two or three co-ordinates.
- It is origin for the conception, perception, evolution, and formation of all geometrical figures constituting fundamental building blocks of any composition, configuration or structure.

Thus, it can be noted that even the concept, evolution and formation of solids or three dimensional figures follow a pattern, sequence and symmetry leading to the formation of series.

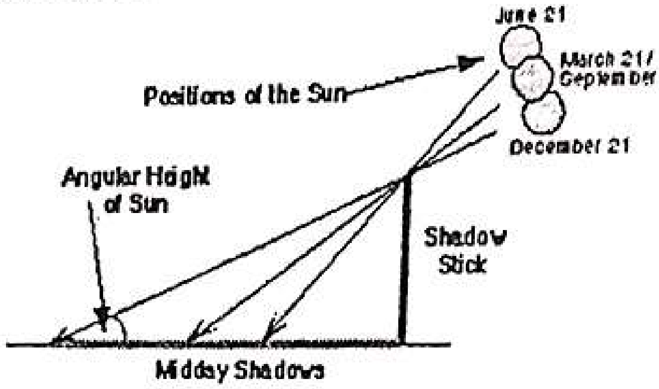
No doubt, there must have been so many trials and errors before visualizing all these numbers and figures. Thus, without thinking process that could have gone into such visualization, the stones would not have attained the size, shape, cutting, chiseling, carving, and finally arrangement attaining a pattern.

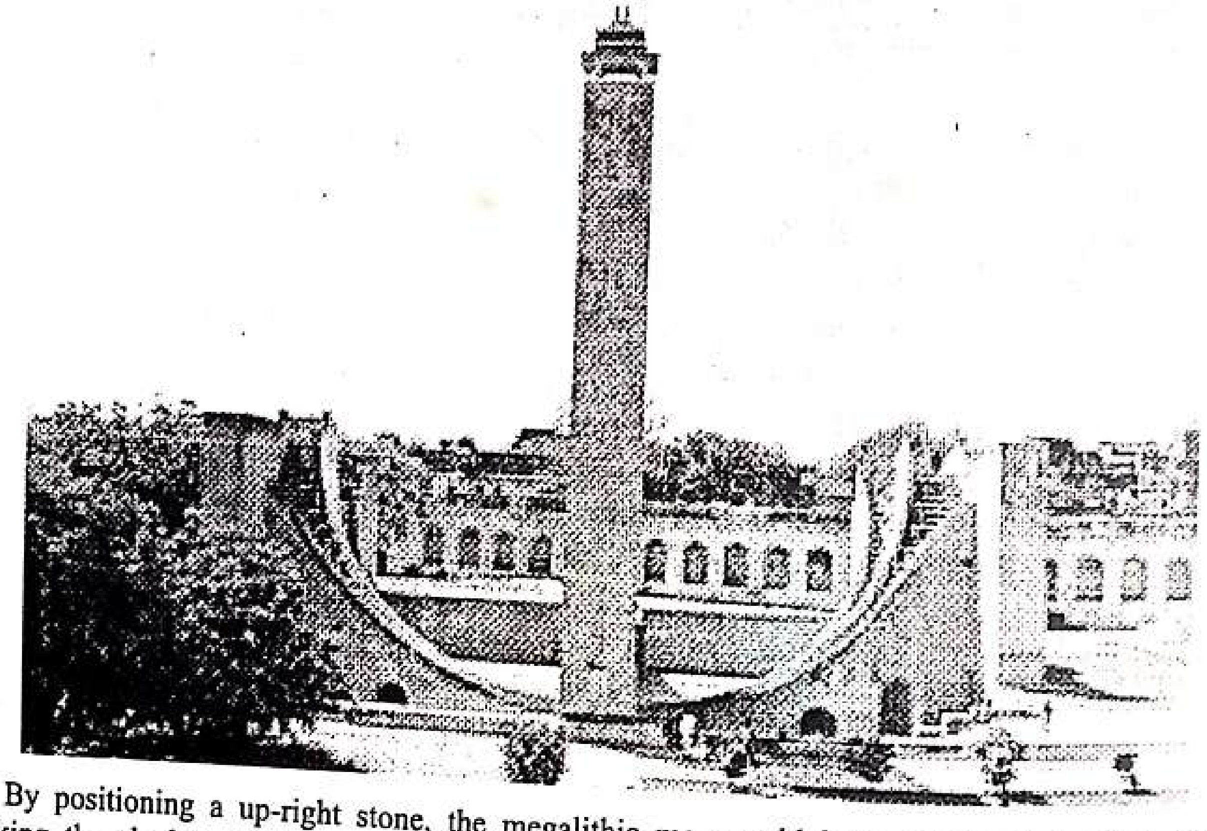
- The arrangement Megaliths in a geometric pattern as noted has been intentionally produced by the Megalithic men.
- The circles and squares have been purposeful, as the circling the square and squaring the circle had been a unique attempt by the mathematicians, astronomers and above all stone sculptors, chiselers and carvers.
- The latter group only knows the difficulty in practice, as they convert ordinary stones into naturally looking shapes, forms and figures.
- Once arranged or constructed, the group would have devised a method of conveying underlying principles to others.
- The burial monuments might be anathema to others, so they must have devised similar stone structures to express the method of time-reckoning.
- They must have used Megaliths as Sun-dials also.

Erected monuments, alignments and Shadows: The erected monuments like Dolmen, Menhirs, Topikal, Cist and other standing stones have hidden science and technology as pointed out. Having erected, it is intriguing to note that they should have taken such pains only to bury or cremate the dead.

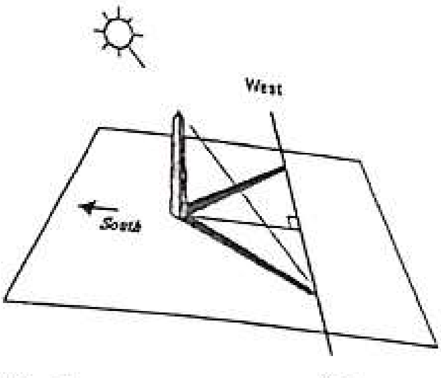
- The east-west orientation of houses has been natural, consistent with the movement of Sun.
- The north-south orientation for the dead is in accordance with Indian tradition and culture. Even, the Tamil literature respect the Southern direction, as they belonged to the forefathers (departed souls / Pitrus).
- As they were well aware of day and night, Sun rise and set, Moon, Stars etc., time reckoning methods must have been in existence and the shadow observation could have been related to Sun-dials.

Sundial is a simple instrument for measuring time, by means of the location on a plane of the shadow cast by a marker exposed to sunlight. It consists of a gnomon and a dial plane marked. The gnomon is the shadow-producing device, a wooden or metal pole or erected stone set parallel to the earth's axis and pointing toward the celestial pole. The dial plane is the flat surface marked with the times of day. A sundial is specially designed for its location on the earth, and tables are used to calculate standard time from solar time, because solar time changes daily with the position of the sun. They could have differentiated between the time noted by the motion of Sun (Solar time), Stars (sidereal time) and revolution of earth around Sun (ephemeris time). The first two methods are based on the daily rotation of the earth on its axis determined by the apparent motion of the sun in the sky (solar time) and by the apparent motion of the stars in the sky (sidereal time) and the third method of measuring time is based on the revolution of the earth around the sun (ephemeris time).

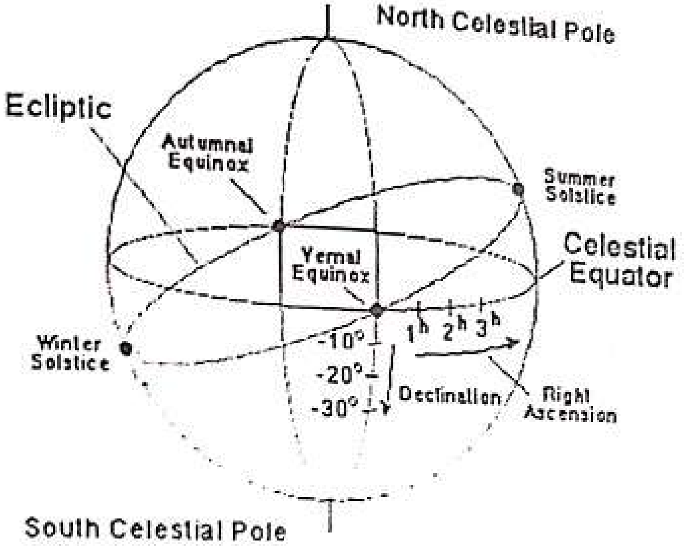




By positioning a up-right stone, the megalithic men could have constructed a Sun-dial by marking the shadow of the stone at equal intervals. Once the day and night and hours were determined, with the movement of Sun from north to south and south to north, vernal equinoxes would have been determined.



The significance of March 21, June 22, September 23 and December 22 would have been understood. Later they could have used for calculating their position with reference to longitude, by marking the shadow regularly to observe periodical autumnal and winter festivals. The close or interacting groups would have also shared their knowledge of observation.

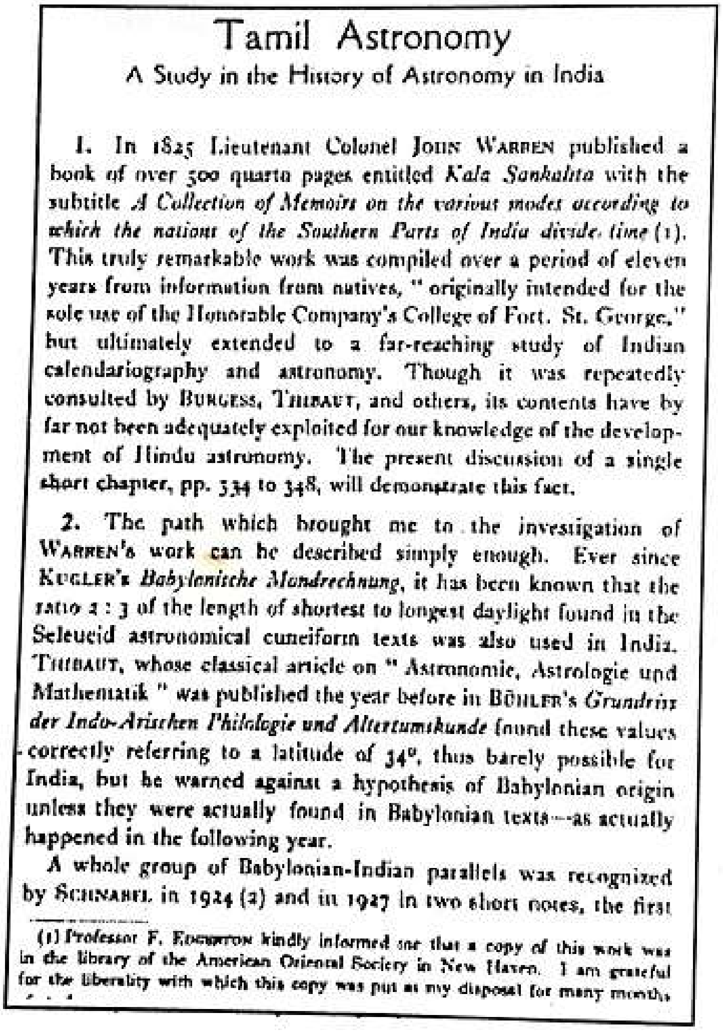


The Astronomical instruments used by the Megaliths: Based on the above evidences and discussion, the prevalent of certain specific astronomical instruments are noted and detailed as follows:

Water clock or Clepsydra: Vedanga Jyotisa, the earliest extant work refers to usage of water clocks. Though, it is dated to *c.*1400 BCE based on internal evidence, the work must have belonged to the earlier period, as such astronomical compendium could not have come into existence suddenly. Water clock is a simple vessel with a small opening at the bottom permitting water to fall drop by drop according to the time reckoning. Here, some marking must have been there on the vessel to determine / know the time. The sinking type clock contains another vessel, in which the drops are collected, which has markings on it to know the time. Surya Siddhanta (it is dated differently from 21,64,960 YBP to 400 CE), the earliest extant Siddhanta work mentions about clepsydra is "a

hemispherical copper vessel with a hole in the bottom, set in a basin of pure water, sinking sixty times in a day and night, and it is an accurate hemispherical instrument" (XIII.23). It describes many instruments used to measure time, degrees, etc. made of wood and metal. They were wooden globe, scale, graduated hoops in degrees, Sun-dials, perpetual calendars, equinoctial chords, day-radii, gnomon, staff of different types.

By mentioning Sanskrit texts in the context of South Indian megaliths, the scholars need not get surprised, or perturbed to object. It has to be mentioned that the astronomical work "Kala Sankalita" was used for time-reckoning throughout the South India.[9] O. Neugebauer's article may be seen (a specimen is depicted below). In fact, Aryabhata hailed from South India only. Most of the India astronomers who wrote in Sanskrit conducted observations only from the South. The Tamil Epic meticulously describes about an observatory "Chakravalakottam". Therefore, scholars should consider all facts in a multi-disciplinary approach, instead working in isolation or with ideology.



Tamil Astronomy

A Study in the History of Astronomy in India

1. In 1825 Lieutenant Colonel John Warren published a book of over 500 quarto pages entitled *Kala Sankalita* with the subtitle *A Collection of Memoirs on the various modes according to which the nations of the Southern Parts of India divide time* (1). This truly remarkable work was compiled over a period of eleven years from information from natives, " originally intended for the sole use of the Honorable Company's College of Fort. St. George," but ultimately extended to a far-reaching study of Indian calendariography and astronomy. Though it was repeatedly consulted by Burgess, Thibaut, and others, its contents have by far not been adequately exploited for our knowledge of the development of Hindu astronomy. The present discussion of a single short chapter, pp. 334 to 348, will demonstrate this fact.

2. The path which brought me to the investigation of Warren's work can be described simply enough. Ever since Kugler's *Babylonische Mondrechnung*, it has been known that the ratio 2 : 3 of the length of shortest to longest daylight found in the Seleucid astronomical cuneiform texts was also used in India. Thibaut, whose classical article on " Astronomie, Astrologie und Mathematik " was published the year before in Bühler's *Grundriss der Indo-Arischen Philologie und Altertumskunde* found these values correctly referring to a latitude of 34°, thus barely possible for India, but he warned against a hypothesis of Babylonian origin unless they were actually found in Babylonian texts—as actually happened in the following year.

A whole group of Babylonian-Indian parallels was recognized by Schnabel in 1924 (2) and in 1927 in two short notes, the first

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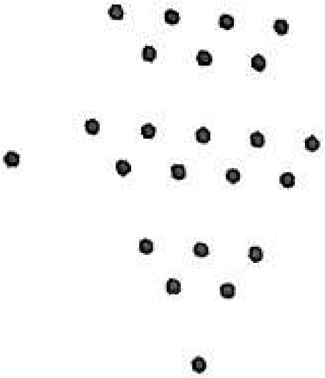
(1) Professor F. Edgerton kindly informed me that a copy of this work was in the library of the American Oriental Society in New Haven. I am grateful for the liberality with which this copy was put at my disposal for many months.

John Warren had traveled extensively in Southern India and had recorded the astronomical lore of the natives in the book mentioned, published in Madras in 1825. In this book, he describes a method followed by the Tamil inhabitants of the Coromandel coast for the computation of the lunar motion.

His informants no longer had any idea about the reasons for the single steps which they performed according to their rules. The numbers themselves were not written down but were represented by groups of shells placed on the ground, Thus means 7 zodiacal signs and 19; 5,1° [apparently, the "shell" to the far left = 10]. Nevertheless they carried out long computations for the determination of the magnitude, duration, beginning and end of an eclipse with numbers which run into the billions in their integral part and with several sexagesimal ["...based upon the number 60"] places for their fractions. Simultaneously they used memorized tables for the daily motion of the sun and moon involving many thousands of numbers. One begins with the "Devaram" period $D = 248$ days. From this one forms the Calanilam period $C = 11\ D + \Delta = 3031$ days.

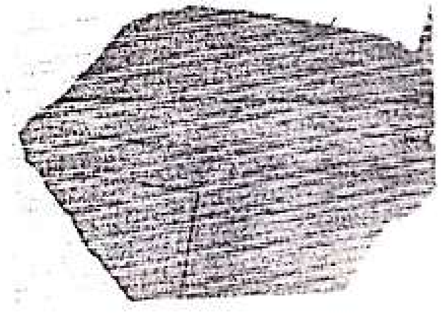


Other Megalithic Instruments: The signs, symbols or graffiti on the pottery profusely contain many geometrical figures of all sizes, shapes and combinations.[10] As they were done manually in specific cases, it is evident that they had marked such geometrical figures purposely in mathematical aspect and not for any other purpose, because of the attempts made by them are recorded on the pottery. Though, half of the figures appear to be scratches made others are meticulously done.

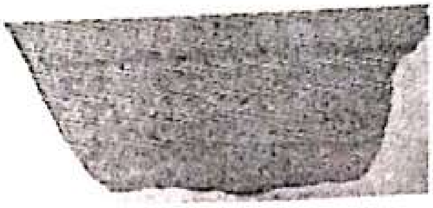
There have been thousands of pottery with characteristic shape- with spherical top and funnel bottomed ones with a small hole at the bottom, which are nothing but clepsydras only. But the archaeologists who studied pottery have not pointed out the significance but satisfied with the discussion of the question of whether they were made of "Aryans or Dravidians" or the coming of the Megaliths themselves from outside! Tripods found were used to set the sinking type clepsydras. The ceramic discs, plates or lids marked with divisions at the edges and animal symbolism might point to usage of zodiacal plate used at a particular place. Some illustrative examples are given below from Arikamedu excavations:

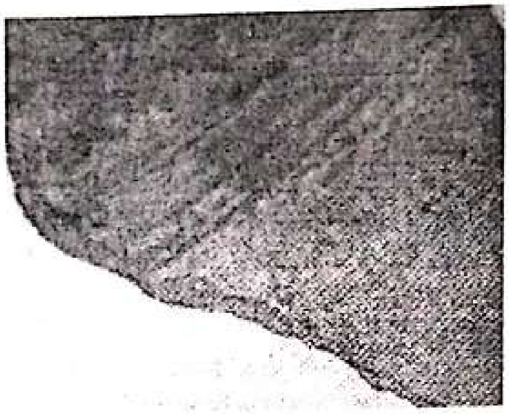
Different layered

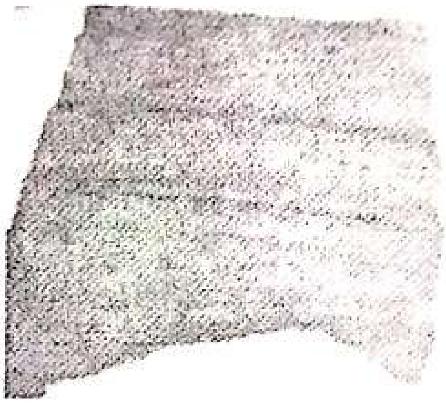
1. First curved designed.
2. Protruded - notched inside - two different designs -1. triangular up-right and reversed
3. square-notched rows



1. first line curved.
2. second crossed-squares with border (diamond shaped)
3. third unclear



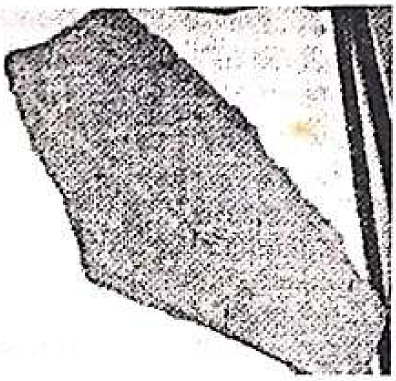




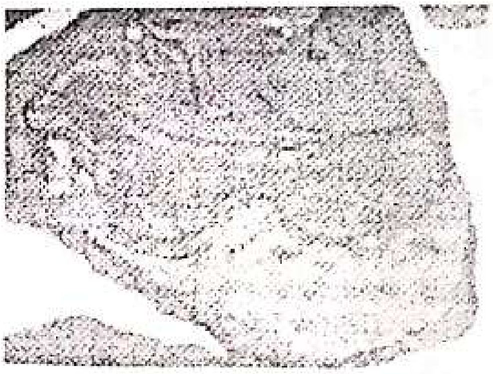
Highly decorated different rows:

1. squares crossed
2. rope design
3. irregular circles
4. ribs
5. unclear designs

1. slanting lines
2. rib design
3. curved shape
4. rib
5. unclear-design
6. rib etc.

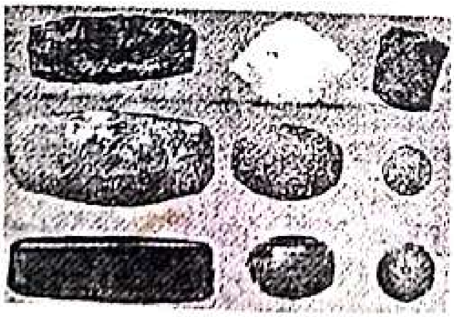


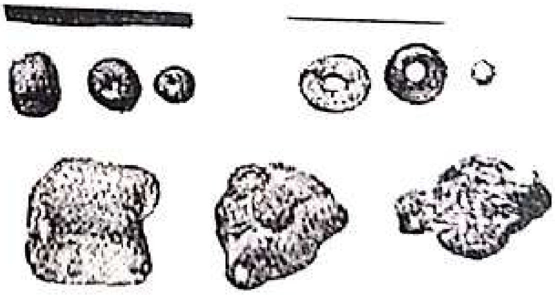
Diamond-shaped rows

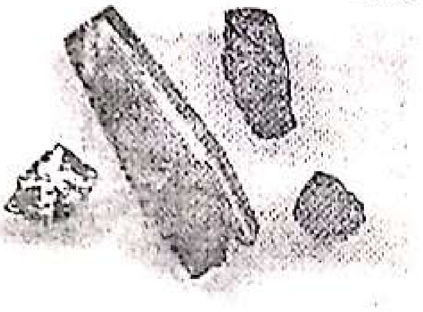


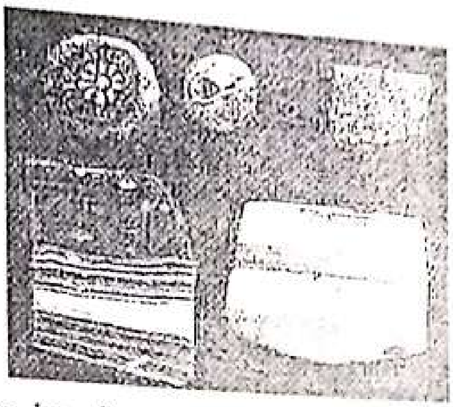
Floral design

For Arikamedu geometry of beads, see the figures below :









Though some scholars[11] wondered about the luxurious usage of toiletry items like mirrors, razors, combs, nail-parers etc., they have not said about the technology employed behind them. It has to be mentioned that the western civilizations did not have the concept of taking bath and therefore their dwelling places had no bathroom.

And it would be more surprising if pointed out that the Kashmir Neoliths[12] were experts in skull surgery c. 4300 to 4000 YBP or c. 2300 to 2000 BCE. Yes, the Neolithic pit-dwellers of Burzahom in the Kashmir valley were engaged in the surgical practice of trepanation also known as or trephination nothing but craniotomy of drilling / cutting through the skull vault of a living or recently deceased person. Of course, the Harappan, Lothal and other Indus / Saraswati Valley people had also known it.

The broken pottery pieces might not have been arranged properly by the archaeologists who did not know the concept of zodiac. Many times, they simply explained away mentioning as "decorated shreds". The Piklihal painted jar is just mentioned as "painted jar" without analyzing as why circle drawn on LHS of the man is divided exactly into six parts without a compass or the Arikamedu lids should have six petalled flower surrounded by three concentric circles, Swastika symbol, animals etc.

Of course, the instrument made of wood must have decomposed during the c. 2000-500 BCE period. However, as the divisions and markings are there on the pottery, textiles and megalith arrangement, the science and technology behind them cannot be ignored.

Y. Ohashi[13] pointed out the usage of Gnomon (Sanku) and the bricks arranged in circular platform by the people of IVC. M.V. Visweswarayya[14] possesses a Kiranada kallu with zodiacal signs on the border (photo appearing in N.K. Rao's[15] article). K. Peddayya has brought out the astronomical observatory feature of stone arrangement of Hanamsafar Megaliths.

Conclusion: Indian time-reckoning has been meticulous and associated with day-to-day processes and activities. Periodical rites, rituals and ceremonies mark summer and winter solstices. The usage of flowers, fruits, herbs, leaves of different trees, plants, grains, seeds etc., in such rites, rituals and ceremonies have been seasonal marking yearly divisions. Even day and night time-reckoning has been associated with day activities systematized and conditioned with Samaskaras. In short, everything has been in consistent with nature and thus amply reflected in the Indian literature.

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S. *Gurumurthy*, *Archaeology and Tamil Culture*, University of Madras, 1974.

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   Anit Sule just mentions that there have been 43 Megalithic sites identified as associated with astronomical sificance without mentioning details: http://www.aip.de/~aniket/ancient. pdf

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    H. Sarkar, *Some Aspects of the Buddhist Monuments at Nagarjunakonda*, Ancient India, No.16, 1960, pp.65-84.

    The stupas have plans of circular shape with 4, 6, 8, 10 spokes thus, making different sectors of angular measurement. This can be compared with Megalithic structures.

    For Arikamedu terracotta and beads see: www.arikamedu.com
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14. K. Peddayya, his article in *Sri Nagabhinadanam*, (*M.S. Nagaraja Rao Felicitation Volume*), 1995, Bangalore.
15. Though, I have not read the above two articles (Sl. No. 13 & 14), I am referring to as N.K. Rao has mentioned in his paper that is available in the internet:

    http://www.ncra.tifr.res.in/-basi/05December/3305499-511.pdf